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Crop Management Facts

Nitrogen Fertilization of Barleys in Manitoba

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Determining nitrogen fertilizer rates is a key management decision of Manitoba barley producers every year.

To determine the optimum level of nitrogen to apply, barley producers need to consider current market conditions, as well as end use of their crop. Malting barley commands a premium market price, but most barley grown in Manitoba is used for feed.

In the past, the standard variety in Manitoba has been Bonanza. Though a malting barley, Bonanza is often downgraded to feed because of failure to meet specific protein requirements required by the malt industry.

Nitrogen recommendations developed during the 1970s for Bonanza have served as a valuable fertilizing guideline. The trend toward newer varieties specifically developed for use as livestock feed has now brought these older fertilizer recommendations under question. These new varieties tend to be higher yielding and have not been developed with malting protein quality in mind.

In 1986, Agriculture Canada initiated a study at the Brandon Research Station to investigate how five of these newer feed varieties, as well as Bonanza, responded to

TABLE 1
Varieties of Barley Used in the Nitrogen Fertility Study

Variety	Source	Height	Type
Bonanza	Agriculture Canada, Brandon, 1970	Standard	Malting
Bedford	Agriculture Canada, Brandon, 1979	Standard	Feed
Duke	University of Saskatchewan, 1985	Semidwarf	Feed
Heartland	Agriculture Canada, Brandon, 1984	Short	Feed
Samson[1]	Alberta Agriculture, Lacombe, 1984	Semidwarf	Feed
Virden	Agriculture Canada, Brandon, 1987	Standard	Feed

[1] Not recommended in Manitoba

TABLE 2
Site and Soil Information for the Barley Trials

SITE & SOIL	PREVIOUS CROPS			AVAILABLE NITRATE-NITROGEN TO 60 CM (24 IN.) KG/HA (LB./ACRE)		
	1986	1987	1988	1986	1987	1988
Minnedosa (Newdale clay loam)	Canola	Flax	Canola	50 M (45)	22 VL (20)	33 L (29)
Souris (Souris fine sandy loam)	Canola	Canola	Wheat	37 L (33)	21 VL (19)	49 M (44)
Clanwilliam (Newdale clay loam)	Canola	Flax	Buckwheat	49 M (44)	24 VL (21)	32 L (28)

Note: Nitrogen level: VL = very low, L = low, M = medium

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different levels of nitrogen. The feed varieties used in the study included Bedford (standard height), Heartland (short strawed), Virden (standard height) and Bonanza (standard height malting barley). (Table 1)

A three-year study was conducted on a wide range of soils in southwestern Manitoba (Table 2) in co-operation with the Western Fertilizer and Chemical Dealers Association with funding from the Agri-Food agreement. The results of these trials were compared with "target yield" curves, the basis for the nitrogen recommendations now used in the soil testing program. The major findings of the study are summarized here, along with some general guidelines for nitrogen fertilization.

Yield Response to Moisture Conditions

The field trials conducted during the 1970s showed nitrogen fertilizer had a greater effect on barley yields as soil moisture increased (Figure 1). Therefore, existing soil testing guidelines suggest using greater amounts of fertilizer in areas of the province with higher average precipitation or on soils with a high water holding capacity.

According to the 1986-88 study, the present moisture-based target yield curves for nitrogen use are still valid for Bonanza, but **not** for the newer feed cultivars. These newer varieties, particularly Virden and Heartland, the two most recently developed in Manitoba, outyield Bonanza for both "dry" and "moist" conditions. Nitrogen response curves for feed barleys under **dry soil moisture** conditions (Figure 2) showed that at equivalent nitrogen supply levels Virden outperformed all others, followed by Heartland. Bedford was slightly better than Bonanza.

Under **moist soil moisture conditions**, (Figure 3), Heartland and Virden out-performed Bedford and Bonanza at equivalent nitrogen supply levels, especially at the higher levels. At the higher nitrogen supply levels, Bonanza showed the poorest yield per unit of nitrogen supply.

The response of the semi dwarf varieties Duke and Sampson to nitrogen supply was similar to Bonanza under dry soil moisture and between Bonanza and the new feed varieties under moist soil conditions. Because Duke and Sampson are not commonly grown in Manitoba, discussion is limited to the other varieties of barley.

In the provincial soil testing program, yields of the newer feed varieties, Heartland and Virden were averaged to revise the dry and moist target yield curves for feed barley cultivars. Compared to existing curves, the dry curve is 12 per cent greater while the moist curve is 24 per cent greater for Heartland and Virden, reflecting the higher yield potential of these varieties. It should be noted that the older feed variety, Bedford, yielded similar to Bonanza under dry soil moisture conditions and between Bonanza and the newer feed varieties under moist soil conditions.

The existing curve is still used in the nitrogen recommendations for the malt barleys. If yields happen to be reduced due to adverse growing conditions, the protein content may exceed acceptable levels for a malt grade.

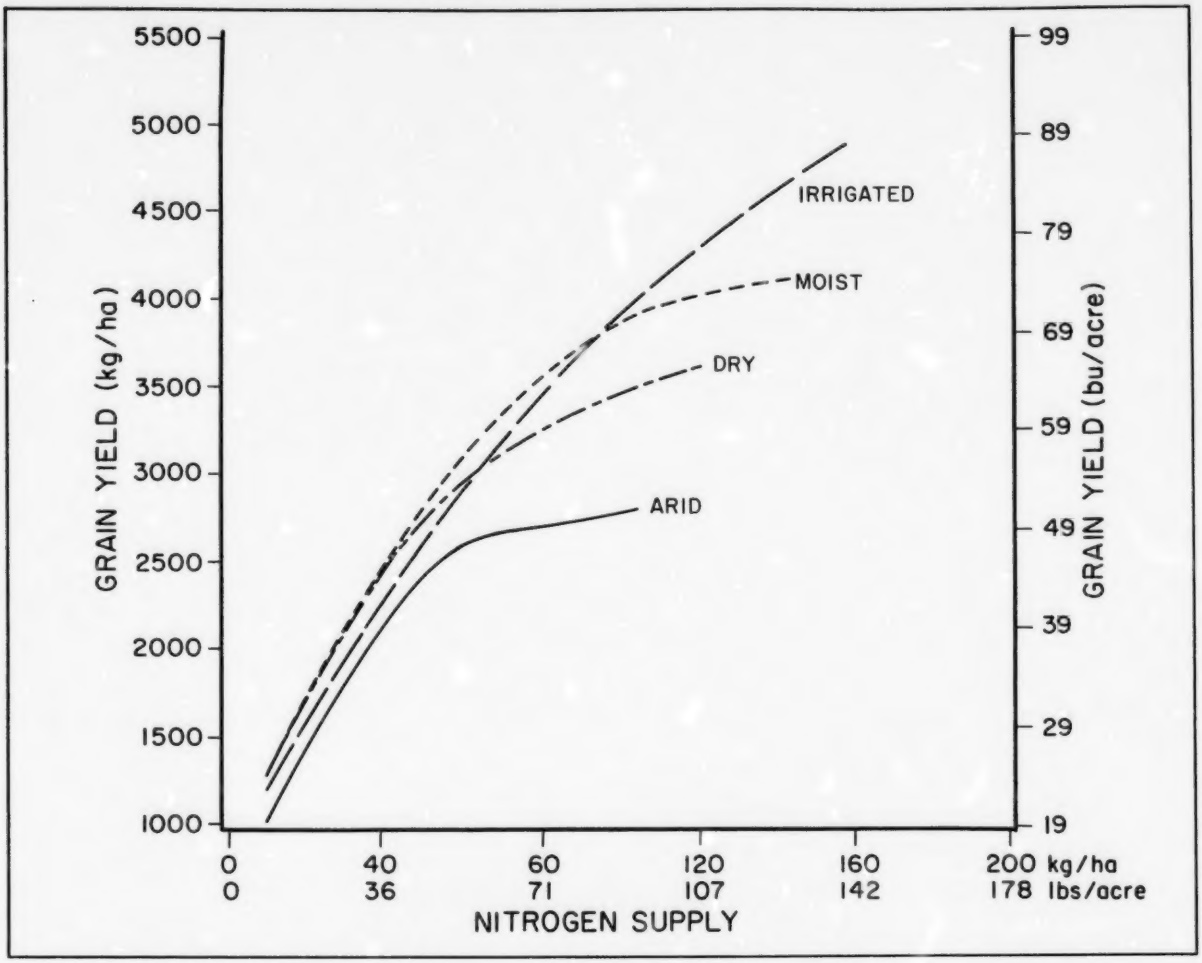
TABLE 3

Nitrogen Supply Levels Needed for a Marginal Rate of Return Greater Than or 1.5 for Barley Cultivars

VARIETY AND SOIL MOISTURE	LOW PRICE		HIGH PRICE	
	N SUPPLY KG/HA (lb./acre)	EXPECTED YIELD kg/ha (bu./acre)	N SUPPLY KG/HA (lb./acre)	EXPECTED YIELD kg/ha (bu./acre)
	MALTING BARLEY PRICE RANGE			
Malt	price = $103/tonne	($2.25/bu.)	price = $184/tonne	($4.00/bu.)
dry soil	80 (71)	3250 (60)	95 (85)	3400 (63)
moist soil	100 (89)	3900 (72)	110 (98)	4000 (74)
	FEED BARLEY PRICE RANGE			
Feed - Old	price = $80/tonne	($1.75/bu.)	price = $115/tonne	($2.50/bu.)
dry soil	70 (62)	7100 (57)	85 (76)	3300 (61)
moist soil	90 (80)	3750 (70)	100 (89)	3900 (72)
Feed - New	price = $80/tonne	($1.75/bu.)	price = $115/tonne	($2.50/bu.)
dry soil	80 (71)	3625 (67)	90 (80)	3750 (70)
moist soil	100 (89)	4825 (90)	110 (98)	4925 (92)

Nitrogen price = $0.55/kg ($0.25/lb.)

Figure 1: Manitoba Target Yield Curves for Barley



Definition of Terms

Nitrogen supply was defined as soil nitrate nitrogen content to a depth of 60 cm (24 in.) plus fertilizer nitrogen adjusted to account for the "efficiency of recovery" of the applied fertilizer nitrogen. (The efficiency of nitrogen fertilizer band applied in spring is considered to be 60 per cent.)

At the start of the trials, all sites were soil sampled to a 60 cm (24 in.) depth to determine soil nitrate levels before seeding. In the trials, nitrogen application ranged from 0 to 200 kg/ha (178 lb./acre). Nitrogen fertilizer was sideband applied as urea (46-0-0).

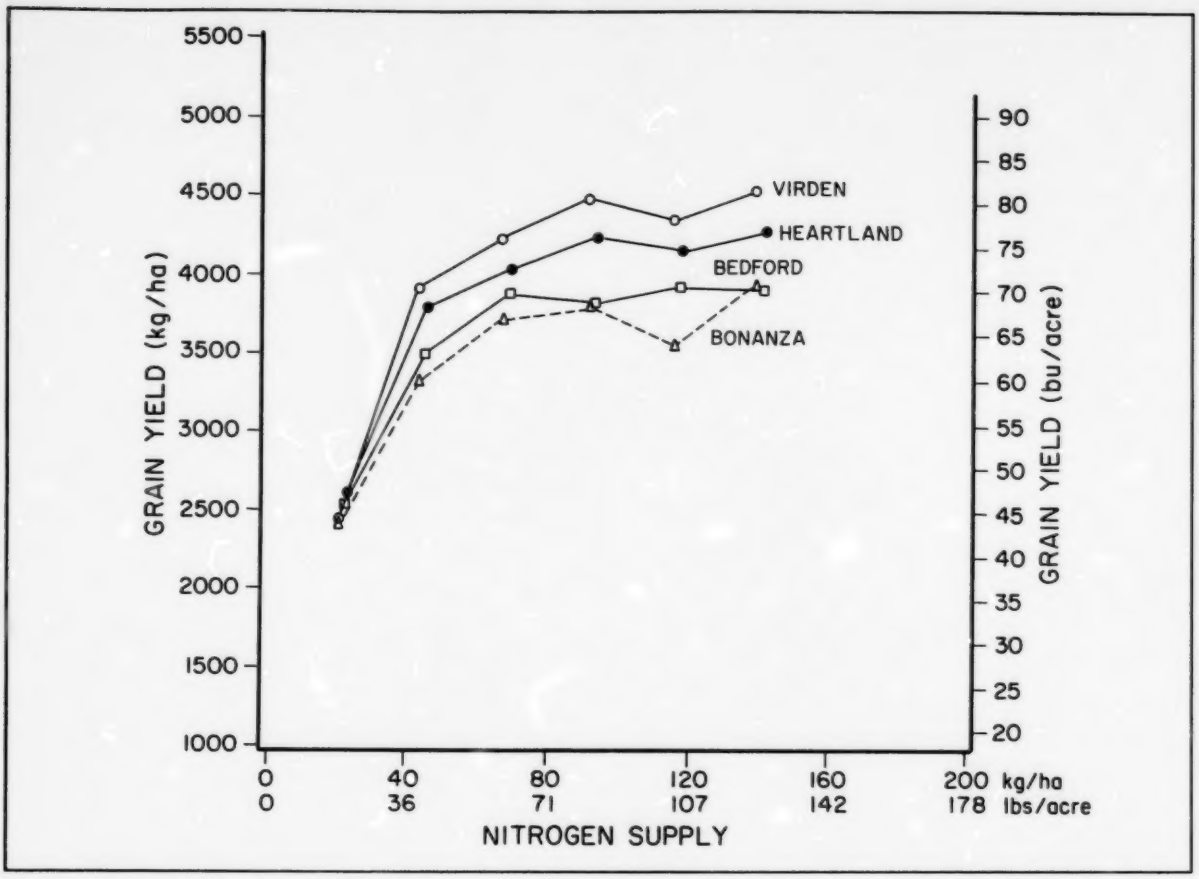
Irrigated Soils – Moisture not considered to be limiting.

Moist Soils – These are the soils which have high water-holding capacities, and/or are in the cooler soil areas but are subject to periodic dry conditions. Included are the Red River Valley clays and the Gray Wooded soils.

Dry Soils – These soils are intermediate in water holding capacity and are subject to dry weather conditions. Included are the medium textured soils in the southwest region.

Arid Soils – These soils have a poor ability to hold water and are subjected to dry conditions on a regular basis. Included are the coarse textured, well drained

Figure 2: Response of Virden, Heartland, Bedford and Bonanza to Nitrogen Under Dry Growing Conditions



Marginal Cost Return

How much nitrogen should be applied to get the best dollar return while minimizing risk for the fertilizer investment?

Several factors need to be considered, including the nitrogen already present in the soil. When soils are low in nitrogen, a small amount of nitrogen fertilizer can cause a significant increase in yields and, in turn, profits. However, at higher levels of soil nitrogen, the addition of fertilizer will have a less dramatic effect on yields and could therefore be less cost-effective.

Soil moisture, grain prices and fertilizer prices must also be considered. As these factors vary from year to year, the fertilizer rate needed for optimum returns will also vary.

As a general rule of thumb, economists say farmers should aim at getting a $1.50 return for every $1.00 spent on nitrogen fertilizer. In other words, the ratio of marginal cost to marginal return (MC:MR) should equal 1.5. This ratio will provide the farmer with a good return, while allowing for unpredictable yield variations or changes in market conditions which would jeopardize economic returns.

Table 3 shows the nitrogen supply levels required to attain an MC:MR ratio of 1.5 for the new and old feed varieties as well as malt variety under dry and moist soil conditions, for an anticipated low and high market price. It is evident that feed barley cultivars Heartland and Virden produce higher yields economically than Bedford or Bonanza. An additional soil nitrogen supply of 5 to 10 kg/ha (4 to 9 lb./acre) or 10 to 20 Kg/ha (9 to 18 lb./acre) fertilizer nitrogen is needed to optimize production of new feed varieties. Although the differences in fertilizer requirements are small between the newer and older varieties, the yield of the newer feed varieties is much greater. Nitrogen requirements for malting barley are similar although yield potentials are lower.

Optimal nitrogen supply levels depend on the price of grain. Higher grain prices make higher N rates economical. This is seen when comparing optimal nitrogen supply levels at high and low grain prices for both feed and malt varieties.

Protein

Malting Barley Bonanza

Table 4 compares the grain protein levels of Bonanza at different nitrogen supply levels and three soil moisture conditions. To be acceptable for malting grade, the grain must contain 10 to 12 per cent protein. Data from this study shows this protein range was only achieved when nitrogen supply was

60 kg/ha (53 lb./acre) or less on dry soils and less than 120 kg/ha (107 lb./acre) on moist soils. Malt grades were not achieved with arid conditions.

Protein levels in barley are determined by the combined effects of the amount of available nitrogen, growing season moisture and temperature. High rates of nitrogen and/or limited growing season moisture supplies will result in protein content above the acceptable level. Protein levels of malting barley grown on droughty soils will generally exceed the acceptable level.

Feed Barley

Tables 5 and 6 compare grain protein content and grain protein yield of the varieties studied. Although new varieties are generally lower in percent protein than Bonanza, they produce more protein per acre because grain yields are higher. Dry soil conditions resulted in higher percent protein content but in a lower total yield of protein.

TABLE 4
Per Cent Grain Protein of Bonanza Under Varying Nitrogen and Soil Moisture Conditions

N Supply		Per Cent Grain Protein		
kg/ha	(lb./acre)	Arid	Dry	Moist
40	(36)	–	11.0	–
60	(53)	13.2	11.8	10.2
80	(71)	14.3	13.0	10.4
100	(89)	15.0	14.4	11.1
120	(107)	15.4	14.6	12.2
140	(125)	15.7	14.6	13.2
160	(142)	15.8	–	13.9

Nitrogen and Soil Type

Soil moisture and texture are important in determining fertilizer rates. Knowing whether your soil is classified as arid, dry, moist or irrigated (ideal) helps determine yield potential. Less nitrogen fertilizer is recommended for soils prone to periods of drought, such as coarse soils in the southwest corner of the province.

Figure 3: Response of Virden, Heartland, Bedford and Bonanza to Nitrogen Under Moist Growing Conditions

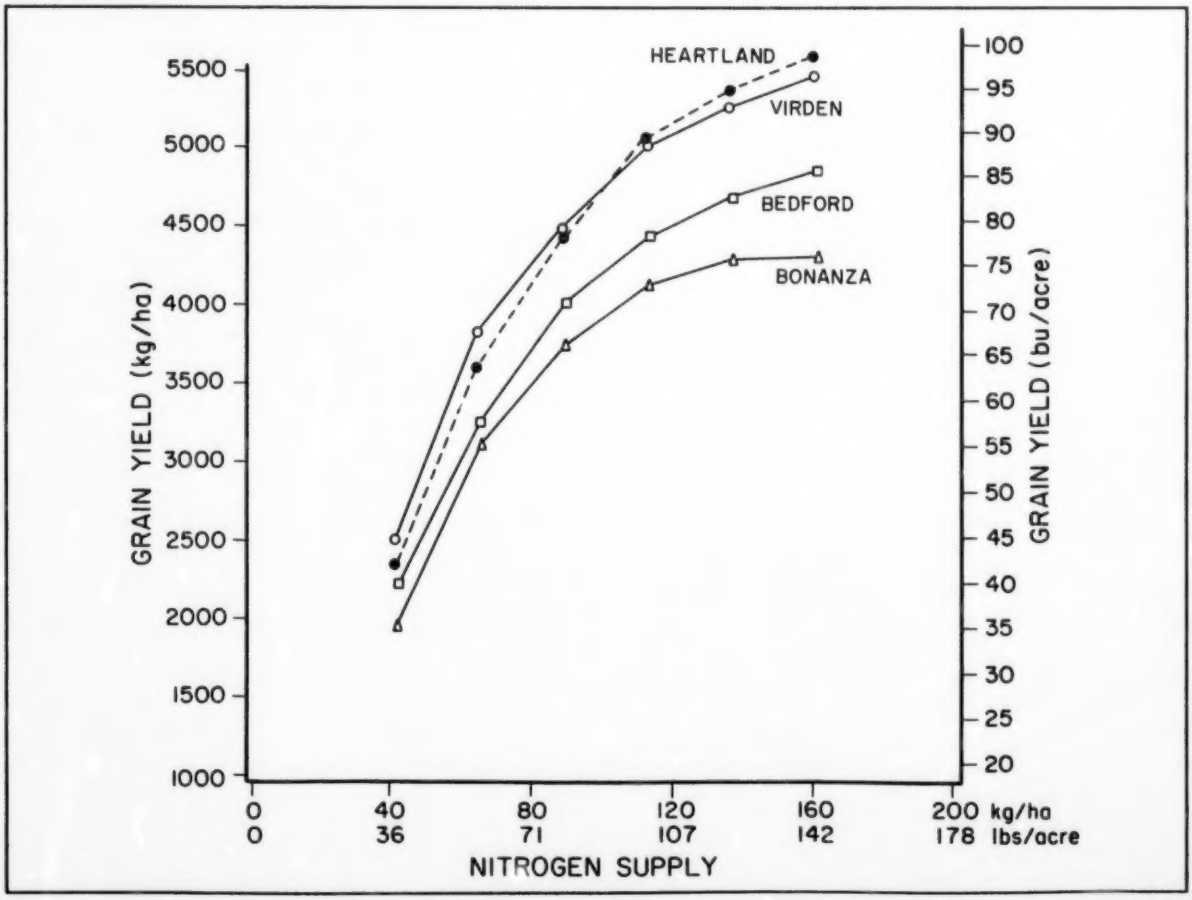


TABLE 5
Per Cent Protein and Grain Protein Yield Under Moist Conditions for Barley Varieties

N Supply kg/ha (lb./acre)	Bedford		Heartland		Virden		Bonanza	
	% Grain Protein	Yield kg/ha (lb./acre)	% Grain Protein	Yield kg/ha (lb./acre)	% Grain Protein	Yield kg/ha (lb./acre)	% Grain Protein	Yield kg/ha (lb./acre)
60 (53)	10.5	300 (268)	9.3	280 (250)	9.3	300 (268)	10.2	270 (241)
80 (71)	10.8	380 (339)	9.5	370 (330)	9.3	380 (339)	10.4	350 (312)
100 (89)	11.3	475 (424)	10.1	460 (410)	9.9	450 (401)	11.1	420 (375)
120 (107)	12.1	540 (482)	11.1	560 (500)	10.6	515 (459)	12.2	510 (455)
140 (125)	13.0	600 (535)	12.0	630 (562)	10.7	560 (500)	13.2	555 (495)
160 (142)	13.4	645 (575)	12.5	680 (606)	12.8	630 (562)	13.9	595 (531)

TABLE 6
Per Cent Protein and Grain Protein Yield Under Dry Soil Conditions for Barley Varieties

N Supply kg/ha (lb./acre)	Bedford		Heartland		Virden		Bonanza	
	% Grain Protein	Yield kg/ha (lb./acre)	% Grain Protein	Yield kg/ha (lb./acre)	% Grain Protein	Yield kg/ha (lb./acre)	% Grain Protein	Yield kg/ha (lb./acre)
40 (36)	11.4	350 (312)	10.4	350 (312)	10.4	340 (303)	11.0	320 (285)
60 (53)	12.3	445 (397)	11.1	430 (384)	10.9	355 (317)	11.8	405 (361)
80 (71)	13.3	515 (459)	11.7	495 (441)	11 7	505 (450)	13.0	480 (428)
100 (89)	14.6	555 (495)	12.2	560 (500)	12.2	555 (495)	14.4	540 (482)
120 (107)	14.7	575 (513)	13.0	560 (500)	13.0	575 (513)	14.6	520 (464)
140 (125)	14.7	575 (513)	13.8	580 (517)	13.5	610 (544)	14.6	560 (500)

An assessment of spring soil moisture may help in adjusting nitrogen rates. Lower rates should be used under dry spring conditions, particularly on sandy soils that have low water-holding capacity.

All these factors are taken into account when soil samples are submitted to the Provincial Soil Testing Laboratory. Samples are classified by soil texture, legal description and current regional soil information. Nitrogen recommendations are then made for the crop to be seeded.

For barley, it is important to indicate whether you plan to grow feed or malting variety. Give the variety when possible, as different recommendations apply.

For more information on soil testing, contact your ag rep or the Provincial Soil testing Laboratory, 262 Ellis Building, University of Manitoba, Winnipeg, Manitoba. Phone: 474-8154

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